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HOW TO MAKE YOUR MILK COOLER HEAT WATER 1/

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Heat removed from milk by mechanical refrigeration during the cooling process can be utilized to save dairymen money expended for room or water heating by using a design based on the heat-pump principle applied to the bulk-milk cooler. A number of applications have been made of the heat energy removed from the warm milk in the cooling process. This report deals with one application that is simple and gives good economy. This application uses part or all of the heat energy removed from the milk and stores it in a preheat tank, which in turn supplies the conventional hot-water tank.

The use of the heat pump to preheat water in the milk house requires a water-cooled condenser rather than an air-cooled condenser on the bulk-milk-cooler refrigeration system. The system produces greatest savings where large quantities of wash water are used, such as encountered with pipeline milking systems and automatic washing equipment. This system requires, in general, the same precautionary measures as required by a water-cooled condensing unit; that is, protection against freezing in extreme temperatures, as well as protection against corrosive water supplies. Water-cooled condensers of a type which may be cleaned should be used if the water supply is at all corrosive.

Figure 1 shows a schematic diagram for connecting the various components; these may be connected with 1/2-inch water lines. For systems using a 1- to 3-hp. condensing unit, a circulating pump of 1/6-hp. capable of delivering 10 gallons per minute against a 10-foot head should be used. For 5-hp. condensing units, a 1/6- or 1/4-hp. circulating pump capable of delivering 15 gallons per minute against a 10-foot head is necessary.

1/ The work reported in this paper is a result of cooperative research between the Farm Electrification Research Branch of the Agricultural Engineering Research Division, ARS, USDA, and the Agricultural Engineering Department, State College of Washington.

2/ Located at the Agricultural Engineering Department, State College of Washington, Pullman, Washington.

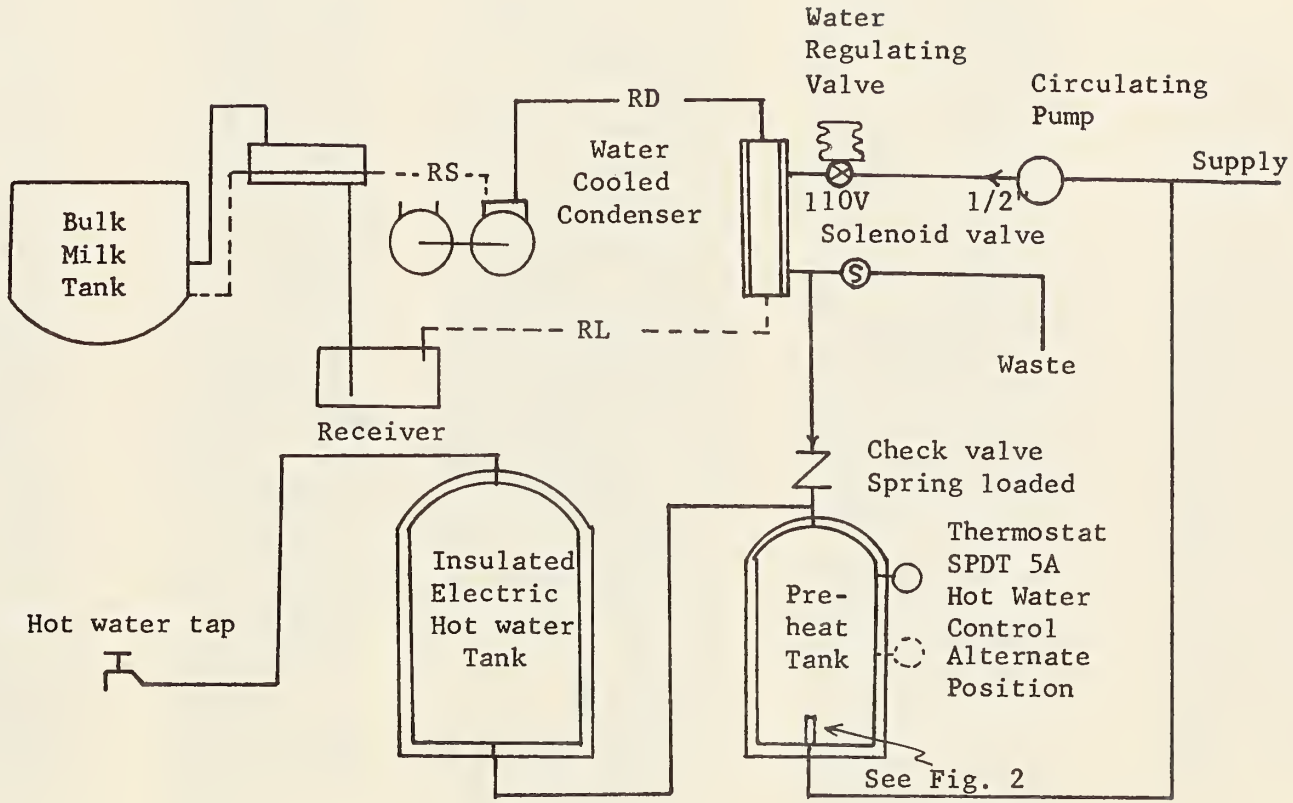


Figure 1. Schematic diagram of milkhouse heatpump.

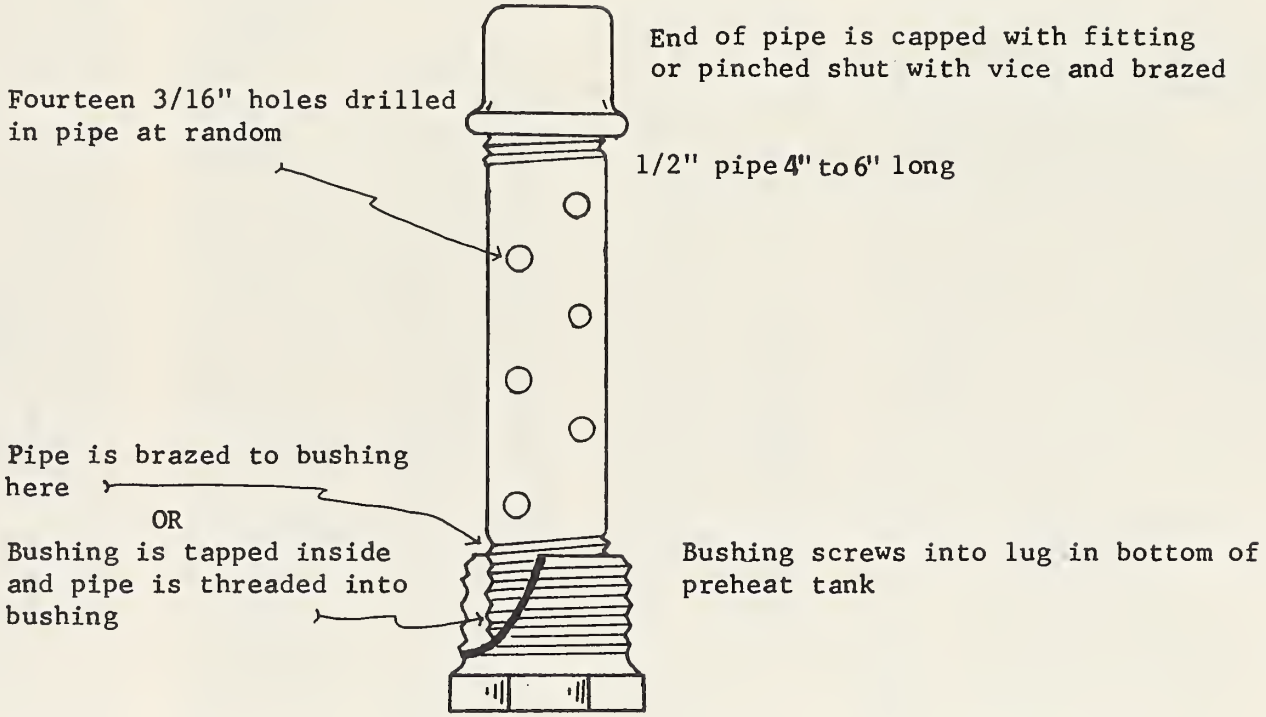


Figure 2. Device put in preheat tank inlet to prevent mixing of warm and cold water when plain tank is used.

The check valve serves two purposes: (1) To maintain supply pressure in the hot-water tank when the waste solenoid valve is open, and (2) to prevent the water from the preheat tank passing through the waste port.

The capacity of the preheat tank should equal the amount of wash water that is used each milking. A plain tank may be used as long as it will withstand the water-supply pressures. It should, of course, have the necessary connections, preferably one at or near the bottom, one at the top, and another on the side near the top or center for the thermostat. A location near the top is more desirable for the thermostat. The tank must be insulated by adding 3-inch blanket insulation. The thermostat used should be a double-throw thermostat, preferably an immersion thermostat, that may be fitted to the connections on the tank. The thermostat rating should be at least 5 amperes to operate the circulating pump; its range should cover the 100° to 110° F. setting. With the thermostat set on 110° F., water should preheat to this temperature without the head pressure going higher than 200 p.s.i. if the circulating pump is functioning properly.

If the milk cooler was installed without a high-pressure cutout, this would be the time to install one. Set it for 200 p.s.i. It would be very desirable to use a conventional hot-water tank for the preheat tank if the thermostat can be added in the place of the upper element. By doing this it offers the advantage of being already insulated as well as having a baffle device in the bottom to prevent mixing of the cold water as it enters.

A word of caution concerning the waste line--it should be installed with enough pitch so that it will drain naturally to prevent freezing. The solenoid valve should be installed as close as possible to the branch tee from the circulating line. For maximum economy the circulating water line should be wrapped with some type of durable insulation. This not only saves the heat, but is an added precaution against freezing in cold weather.

In the event a plain, galvanized preheat tank is used, rather than an additional conventional hot-water tank, it is necessary to provide some type of arrangement at the water inlet so that cold supply water added to the tank is not mixed with the warm water within the tank. To do this, an antimixing device may be made and inserted in the tank inlet as shown in figure 2.

The way in which the bulk-milk cooler is wired and installed and the controls that it has, will determine the way the heat pump is to be wired. If the tank is wired according to ASAE recommendations, the compressor-motor starter or controller will have sufficient contactors so that both hot lines will open when the compressor motor is off. If this is the case,

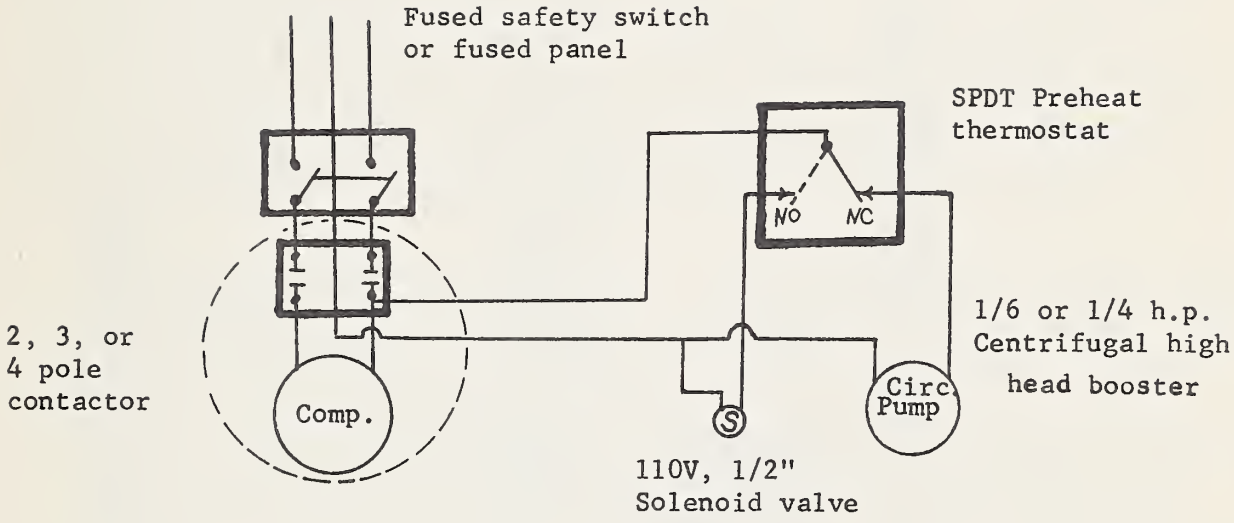
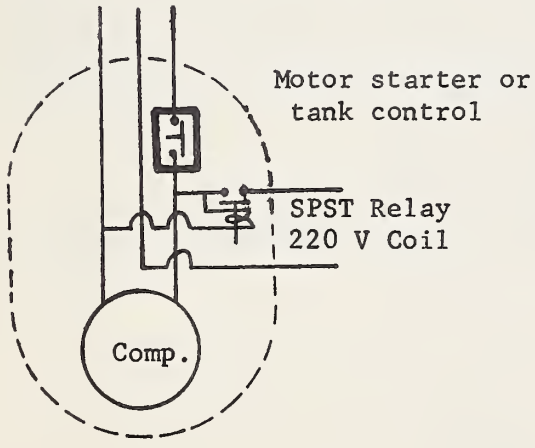


Figure 3. Wiring diagram for milkhouse heatpump.



Alternate hook-up with
220 V relay if motor
starter does not open
both lines.
May be used in Fig. 3 or 4.

Figure 3A.

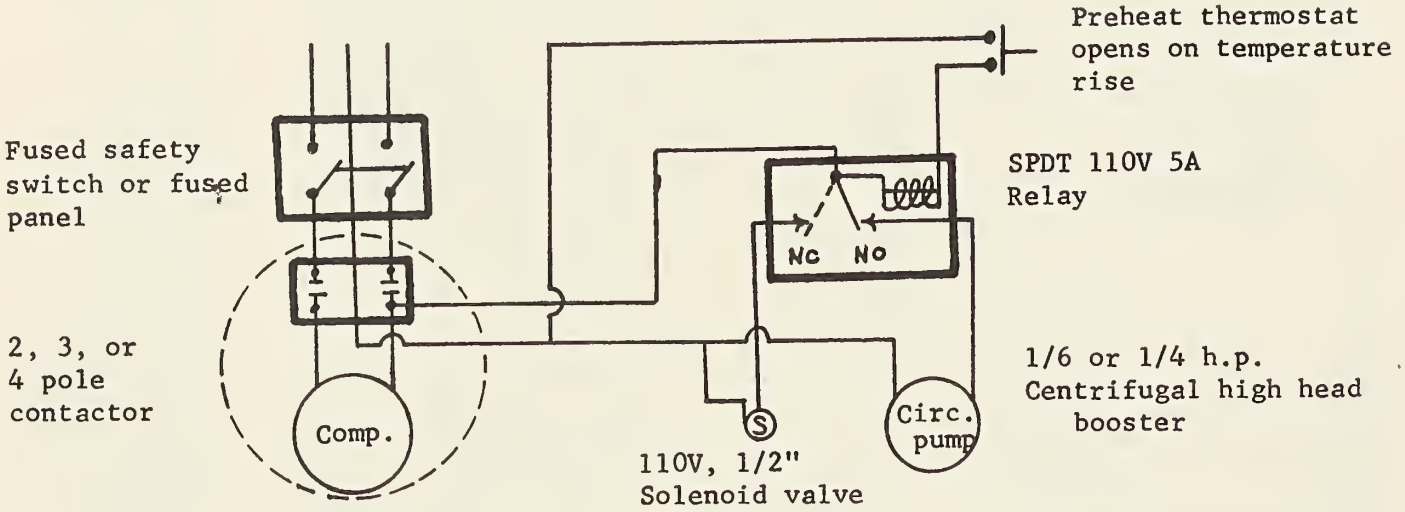


Figure 4. Alternate diagram to be used in place of figure 3 only if SPDT Preheat Thermostat is not available.

you may use the diagram shown in figure 3 with a double-throw preheat thermostat or, depending upon the thermostat used, figure 4 with a single-throw preheat thermostat and a double-throw relay as shown. If the motor starter opens only one side of the 220-volt line, it will be necessary to use additional 220-volt, single-pole, single-throw relay and wire it as shown in figure 3A. Figure 3A may be used in place of the dashed circled portion of either figure 3 or 4. If the milk cooler was installed without a multiple contactor for proper interlock protection between compressor and agitator motors, this would be a good time to make this installation, as well as individual protection for any motors that do not have it.

The wiring for a single-pole, double-throw, immersion-type, hot-water-control thermostat is shown in figure 3. This thermostat is one which turns off the circulating pump and opens the waste water solenoid when the preheat water has reached the required temperature. This temperature is usually 110° F. The thermostat setting should not be higher than 110° F. as most compressors cease to heat water and cool milk economically above this temperature. The thermostat should have a 5° to 15° F. differential; that is, it should shut off the circulating pump and open the solenoid valve at 110° F., and when the thermostat senses water temperature in the preheat tank 5° to 15° F. colder than this, it will switch back and start the circulating pump and shut off the solenoid valve.

In the event a single-pole, double-throw thermostat is not available, a conventional single-pole, single-throw heating thermostat that will sense water temperature will be used. It is necessary, however, to use in conjunction with this thermostat a single-pole, double-throw, 110-volt, 5-ampere relay. This is shown in figure 4. The relay in figure 4 is shown in the operating position for water circulation. When the compressor motor is running, the line to the relay is energized. With the water temperature in the preheat tank below the thermostat setting, the thermostat will be closed and the relay coil will be energized. This closes the relay contact with the normally opened position, which is connected to the circulating pump.

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